CHARACTERIZATION OF EXTREME STORMS ON THE SOUTH-EASTERN SOUTH-AMERICA USING TRMM OBSERVATIONS

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I. INTRODUCTION

Global and regional characteristics of deep convection over South America have been analyzed by many authors based on different observing tools. Satellite infrared images have been the primary tool since the GOES constellation satellite was launched over the region. These data make it possible to understand the evolution and behavior of convective systems over many regions, especially over large areas without ground-based observations. Based on geostationary satellite information, Machado et al (1998), Velasco and Frisch (1987), among others showed the characteristics and structure of mesoscale convective systems over South America. However, there is an important lack of knowledge of the internal structure of convective systems over the area due to the sparse ground-based radar network.

The study of spatial distribution of more intense or precipitant convective systems is very important to understand which are the most vulnerable regions to be affected by severe storms of short duration or more intense convective systems that produce durable and big accumulated rainfall.

The Tropical Rainfall Measuring Mission (TRMM) constellation measures visible and infrared radiances (VIRS), microwave radiance from TRMM Microwave Imager (TMI), radar reflectivity from the Precipitation Radar (PR), and flashes from Lightning Imager Sensor (LIS) (Kummerow et al., 1998).

II. PRESENTATION OF RESEARCH

The University of Utah Version-6 TRMM level 3 dataset (Liu et al., 2008) spatially and temporal collocate all available sensor information from TRMM constellation during a 9-year period (1998-2006). Radar Precipitation Features (RPFs) are defined as "a pure precipitation feature" because considering all Precipitation Features (PFs) in the sample, with TRMM 2A25 surface rain rate greater than 0 mm h^{-1}. The characteristics of each feature are summarized from measurements and retrievals from PR, TMI, VIRS and LIS at grouped pixels.

While RPFs provide valuable information for the South America regions where convection is more frequent as described above, there is a large percentage of precipitation systems by their morphological characteristics introduce a significant noise in the sample if the objective oh this work is analyze the behavior of extreme convective systems. In order to concentrate on a sample that reveals the characteristics of the most important precipitation systems in the area is defined the MRPF (Mesoscale radar precipitation feature, RPFs with surface precipitation field is grater than 2000 km2 and minimun brightness temperature is less than 218K).

This sample data have been analyzed to examine the temporal an spatial distribution of extreme storm with the focus on events over Southeastern South America (SESA). To define extreme events we use the cumulative distribution functions (CDFs) of five parameters asociated with MRPF: volumetric rainfall, MRPF's area, minimum PCT at 85 GHz inside the MRPF, maximum height of 40 dBZ echo-top and flash rate. Table I shows the thresholds considered for each parameter.

Parameter	0,01%	0,1%	1%	10%
Volumetric Rain (mm h^{-1} km^2)	1218746,6 **(4)**	805528,9 **(40)**	363885,4 **(399)**	102736 **(3987)**
Area (km^2)	198603,6 **(4)**	23621,9 **(40)**	66245,4 **(399)**	24050 **(3989)**
Min 85-GHz PCT (K)	52,4 **(4)**	60,5 **(39)**	80,2 **(393)**	118,6 **(3928)**
Max 40-dBZ Echo Top (km)	17 **(7)**	15,75 **(47)**	13,25 **(412)**	8,25 **(4362)**
Flashrate (#/min)	1144,5 **(4)**	386,2 **(39)**	132,8 **(389)**	22,5 **(3886)**

TABLE I: Thresholds for each percentage of extreme events in the distribution of each parameter. In parentheses show the MRPF numbers that exceeds this threshold.

III. RESULTS AND CONCLUSIONS

The map relating to volumetric rain (Figure 1) shows that the preferential region to develop extreme precipitation events is SESA, with particular dominance in the region east of SESA, focusing on the extreme values of the boundary area between Argentina, Brazil and Uruguay. A similar behavior shows the distribution of extreme events defined from MRPF's area, as the preferential region coincides with the region east of SESA. This result would corroborate the fact that the large cumulative precipitation occurring in this region of the continent are generated by large mesoscale convective systems that affect this region more frequently and preferentially during austral spring and summer.

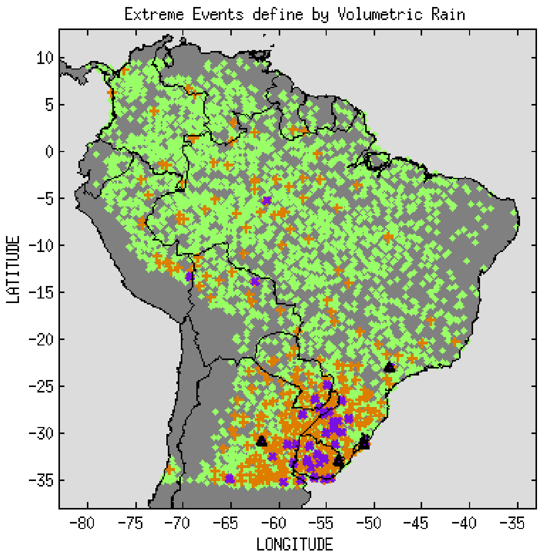

FIG. 1: Location of most extreme convective events defined from volumetrica rain. They are segmented from the threshold shown in Table I. The color code is: ▲ 0.01%; X 0.1%; + 1% y e 10%.

For its part, the extreme events of minimun 85-GHz PCT (Figure 2) shown as preferential SESA region, but also include maximum frequency, although to a lesser extent on the northwestern part of Colombia and Venezuela. About SESA these intense events tend to cluster in this case mostly on Argentina (west of SESA), especially the most extreme cases (0.1% and 0.01%).

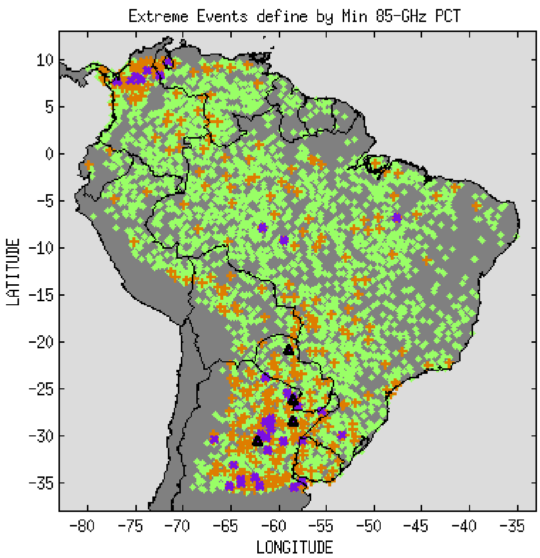

FIG. 2: Location of most extreme convective events defined from minimun 85-GHz PCT. They are segmented from the threshold shown in Table I. The color code is: ▲ 0.01%; X 0.1%; + 1% y e 10%.

For the location of more intense events defined by the maximum height of 40-dBZ echo top (not shown) is observed that the distribution is very similar to Figure 2. This may be related to the fact that this last parameter provides information on the presence of ice into the storms. Thus, these systems are also more likely to show reflectivities of 40 dBZ reaching high levels. In this case, it appears that the extreme events of the present MRPFs ceiling heights of 40 dBZ echo beyond the 15km especially over Argentina and a few to 17 km, also in this region. For their part, are systems on the Altiplano not been watching with the other parameters, with peaks characteristic of the order of 8 km concentrates mainly during spring and early austral summer. While these heights of 40 dBZ cores would indicate that they have a significant vertical development, we must remember that the surface in this region of South America lies on average between 4 and 5 km above mean sea level.

Finally, we conclude that the convective systems in SESA reach greater heights, with high content of ice and intense electrical activity to the west, while presenting larger sizes and volumes of rainfall to the east, with a lower concentration of ice and thus less flashrate. Thus, when trying to find phenomena associated with severe hail, strong winds and lightning, the highest occurrence is in the area west of SESA, whereas if what is sought is mainly associated with flood events or large amounts of rainfall within hours, they will be in the eastern region.

In summary, one may interpret that as in SESA-W systems have a surface area of more limited precipitation in the horizontal compared with SESA-E, the percentage of that which presents the more convective zone is larger in the west compared to this. That is, in the western portion of SESA smaller systems would be presented (for the horizontal area) but more and more intense convective compared with systems that are developed to the east, which are larger but with a lower convective area. One possible explanation for these differences could be in the zonal stressors that trigger the convection on either of the regions, while the west is dominated mainly by the rise in summer orographic generated isolated deep convection in the eastern convective systems dominate mesoscale that are characterized by large areas of stratiform precipitation compared to more convective zone. Anyway, regarding the contribution of precipitation in SESA-E are given in most of the year more precipitating systems, reversing the situation alone for DEF where more precipitating systems are located in SESA-W.

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